EFFECT OF NOVEL PLASMA TREATMENT ON SUPERFILLING BEHAVIOR IN CHEMICALLY ENHANCED CVD (CECVD) CU PROCESS

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Copper has been considered as a prime candidate which can replace aluminum for the future ULSI devices. Especially, MOCVD Cu process has been widely studied which can replace electroplating process for sub 100nm technology and it has been paid much attention in recent years. However, Cu MOCVD process to apply in sub 100nm technology generally suffers from rough surface film, which makes it difficult to fill the trench lines and via holes with high aspect ratio in 0.1 ㎛ technology node.

In our previous result [1], we showed that CECVD Cu process introducing CH_2I_2 as a catalysist and surfactant gives two useful advantages, one for high growth rate and another for smooth film surface. It would be ideal if a simple adsorbate could serve as a catalyst and surfactant without being consumed and incorporated into the growing film. That is, the catalytic treatment of the adhesion glue layer with iodine increases the deposition rate and increases the nucleation density of the copper film. It has been argued that in the MOCVD Cu deposition process using the precusor of (hfac)CuTMVS the rate limiting step is the disproportionation of the TMVS ligand from the precursor. In this case, the role of catalysist can be to destabilize the bond between Cu(hfac) and TMVS and help accelerating their separation and leading to the increased deposition rate. And also we observed that CECVD Cu film has superfilling characteristic in the previous result.

Cu film was deposited by using the precursor of hfac(Cu)TMVS on the ionized PVD TaN_x(300Å) film. The TaN_x film was deposited on the thermally grown silicon oxide(1000Å) on the 8 inch bare Si(100) wafer. Before MOCVD Cu deposition, the TaN_x film was treated with CH_2I_2 adsorbate as a catalytic surfactant followed by the dual frequency plasma treatment.

Figure 1 clearly shows selective superfilling of CECVD Cu for the trench lines (Fig. 1(b) and via holes (Fig. 1(c)) compared to the conformal step coverage behavior of MOCVD Cu film (Fig. 1(a)). Even though superfilling nature in CECVD Cu film has been achieved, however, it shows always non-uniform-superfilling behavior (Fig 2 a)). The main objective of this study is focused on the improvement of non-uniform superfilling nature of CEMOCVD Cu film. The introduction of dual frequency plasma treatment after the catalytic treatment with CH2I2 for the pattern wafer shows uniform superfilling nature through the whole wafer position.

The present study will represent that CECVD process using a catalytic surfactant treatment can be the ideal candidate for an application to sub 100nm technology (Figure 3). And also we will discuss optimization condition and limitation of superfilling nature of CECVD Cu process

References

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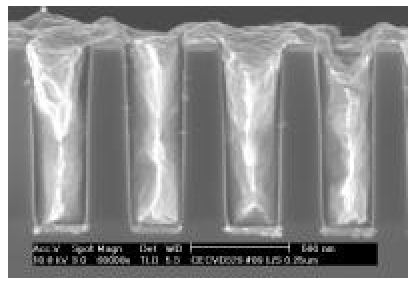
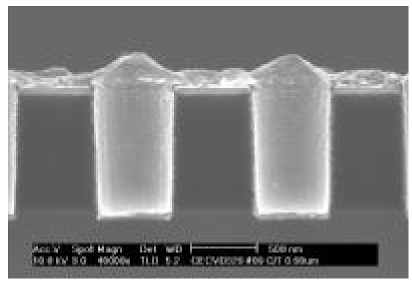
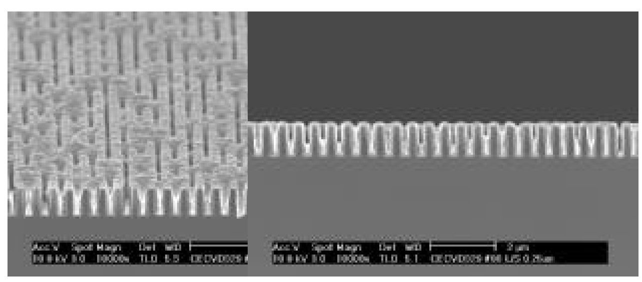


a)

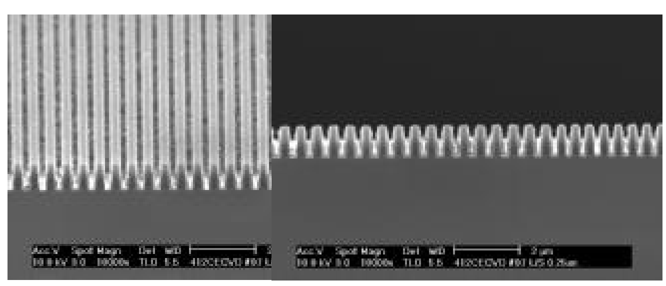


b)

Fig. 1 . SEM images showing a) selective superfilling characteristics in trenchs and b) in via holes of CECVD Cu film



a)



b)

Fig. 2. SEM images of CECVD Cu film showing a) inhomogeneous superfilling without any treatment and b) uniform superfilling with novel plasma treatment

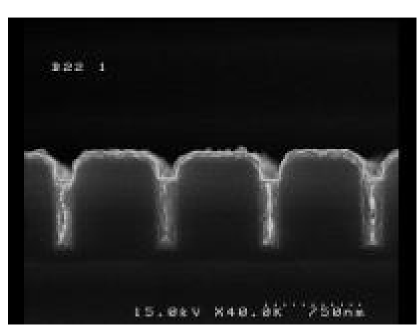


Fig. 3. SEM images of CECVD Cu film in 0.1 ㎛ trench lines with AR=6:1